



Mini Review**Actor network theory in food safety**^{1,2*}Vitalis, R. E., ¹Nor-Khaizura, M. A. R. and ¹Son, R.¹*Department of Food Science, Faculty of Food Science and Technology, University Putra Malaysia, 43400 Serdang, Selangor, Malaysia*²*Faculty of Pharmacy, Lincoln University College, 47301 Petaling Jaya, Selangor, Malaysia***Article history**

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Abstract

Nowadays, the incidence rate of foodborne disease has increased and become one of the global burdens affecting all individual ages in South East Asia region. Foodborne disease is responsible for mortality and morbidity worldwide thus affecting socio-economic and quality of life. Major causes of foodborne hazards diseases include diarrheal and invasive infectious disease agent, helminthes and chemicals. However, in developing countries, data and record is insufficient with poor surveillance systems leading to incomplete information on the real burden of foodborne disease. The introduction of Actor Network Theory (ANT) as tools for assessing and analyzing the food safety issues has drawn attention from various researcher as it is proven to be able to point out and identify the human and non human actors which is directly and contingently involved. The interaction between the actors such as a worker in an organization, student in school, and peoples in public provide information that can be used to minimize the risk of foodborne disease. The ultimate use of ANT is it helps the researcher to draw a framework of the source of contamination, agent responsible, factors involved, and idea to control the spread.

Keywords

Actor network theory
Food science
Food safety
Contamination
Foodborne disease
Cross-contamination
Food poisoning and
compliance on food safety
Food handlers

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Introduction

The prevalence of foodborne diseases worldwide has continuously emerged and affecting the quality of life. In the year of 1999, the World Health Organization (WHO) state that 1.5 billion cases of diarrhea in children reported every year contributing more than three million premature deaths associated with consumption of contaminated food. Furthermore it is estimated that one million children under five years of age die each year suffering from diarrheal diseases linked to unclean food and water supply in South East Asia country including Malaysia (WHO, 1997). The data on foodborne disease is insufficient because many countries have not yet established adequate surveillance or reporting mechanisms thus improvements are needed to identify the main causes of foodborne diseases (DeWaal *et al.*, 2005). The symptoms of foodborne illnesses can be classified from mild to severe including nausea and diarrhea, kidney and liver failure, brain and neural disorders. For instance, a mortality rate between 20-30 percent is contributed by *Listeria monocytogenes* infection in the elderly and pregnant women (WHO, 1999). Economically, foodborne diseases have affecting

the consumer cost including medical, and legal, as well as absenteeism at work or school. Furthermore, the loss of income due to foodborne illness can be responsible for the cycle of poverty for consumers who live at the very subsistence level (WHO, 2005). In Malaysia, cases of foodborne disease are emerging. Due to the suitable temperature and condition for the growth of most bacteria, it is anticipate that the cases of foodborne disease will increase in future (Mutalib *et al.*, 2015). The factors contribute to foodborne disease including contaminated poor self hygiene, contaminated environment and water supply (Meftahuddin, 2002). Food handlers are the most common source of contamination as they spread dangerous organisms through direct contact with the food or using unclean kitchen utensils and contaminated tables (Linscott, 2011). The common agents of foodborne disease are *Salmonella typhi*, *Staphylococcus aureus*, *Escherichia coli* and *Clostridium perfringens* which are associated with food contamination in meats, eggs, vegetables and dairy products (Pires *et al.*, 2012). Foodborne bacteria spread at different stages of food preparation such as at the farm where milk is collected from infected animals or the milk contaminated with animal feces.

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Moreover, transmission can happen during food preparation when slaughtering animals where meat gets direct contact with animal skin, fur and intestine (European Food Safety Authority, 2014). Common symptoms of foodborne disease are diarrhea, and, possibly nausea and vomiting as result from consumption of parasites, bacteria and virus as they multiply in the stomach and intestine. In addition, ingestion of non- infectious agents like toxin and chemicals also lead to foodborne illness (Linscott, 2011). The trend of eating fast food has become very popular in Malaysia as everyone has taken a toll of eating outside to tackle the busy and fast lifestyle. As a result, the demand of food service establishment has increased as well as the risk of getting infected with contaminated food by food handlers (Ali and Abdullah, 2012). Study by Kusumaningrum (2003) and Mattick (2003) proved that foodborne bacteria is able to grow on most of the external surface of cutting board, sink, knife, cloth and cleaning sponge in the kitchen. The study suggests that food handlers should practice the correct way of food preparation and must clean the utensils thoroughly after use. Insanitary food handling procedures has contributed more than 50% of the foodborne disease cases in Malaysia such as preparation of food in advance, incorrect ways of cooling and inadequate temperature during reheating of food (Ministry of Health Malaysia, 2014). It is a fact that temperature played an important role in microbial activity and food product shelf life. Improper handling of food allows the transfer and growth of bacteria increase thus it will be very hard to eliminate or kill. Bacteria also can grow and divide rapidly in suitable condition and enabling it to mutate thus becoming resistant (Aung and Chang, 2013). The emergence and spread of pathogens has continued to develop a problem to industrialized food production associated with a profit-driven industrial production. Thus a complicated interaction between humans and non-humans in food production networks has occurred, while people continue to blame external nature for foodborne illness (Stuart 2011). A reevaluation of centralized systems is needed to effectively minimizing food-borne illness and requires efforts to address outbreaks focusing on controlling non-humans and adopting new technological fixes (Nsubuga *et al.*, 2006). Actor network theory (ANT) can be used to analyze cooperation and innovation in networks, and it is the extent of relationships between actors, and can thus span distances but not necessarily bounded geographically (Jarosz *et al.*, 2000).

Food safety issues

Food safety has become a major concern among countries worldwide as it is affecting the economy related to lower work productivity, hospitalization and various health care expenses. Existence of foodborne illness also has become the clinical and public health problem therefore it is estimated that 38.6 million foodborne illness each year in United States and 13% of it are caused by bacteria such as *Salmonella*, *Listeria* and *Campylobacter* (Buzby, 1996). It is also estimated that 2.4 billion loss in medical cost and productivity cause by infection of *Salmonella* in 1.3 million cases in the year of 2000 (Lynch, 2006). Study shown that, the spread of foodborne illness has begun from home whereby food has been contaminated during meal preparation (Mead, 1999). The most common site of foodborne illness reported are the households, restaurants, and private residences thus consumer food handling and sanitation practices is very important in preventing the foodborne cases (Bermúdez-Millán, 2004). Meanwhile, knowledge and behavior plays an important role in avoiding foodborne illness in the respected sites mentioned (Aletkruse, 1996). In another study, it is stated that potential of food safety threat in household increasing as consumer did not consider foodborne illness as major issue (Redmond, 2005). The survey by the Food and Drug Administration (FDA) found that 56% of consumer often believes that foodborne illness is only occurring in restaurant not at home. This type of belief is responsible in reducing the consumer's precaution on safe food-handling behaviors at home (Lando, 2006). A case-control study conducted in Louisiana found that the transmission of pathogens in household level is high because the consumer did not wash their hands during preparation of meal (Kohl, 2002). Study in United States show that factors involved in foodborne illness are poor hand hygiene and food expose to the contaminated surface (Mead *et al.*, 1997). A household study by Cogan (2002) shows that a bacterium called *Staphylococcus aureus* and *Campylobacter* from chicken can be transferred from hands to kitchen surfaces during food preparation. Meanwhile in another study by Aycicek (2004) state that the most common bacterium found in human hands particularly in hospitals food's handler are *Escherichia coli*. The most vulnerable place for unsafe food-handling practices is at home whereby food safety monitoring systems which is similar to commercial food is not available therefore consumer sometimes neglect the practice of safe food-handling (Griffith, 1998). The different types of practice of food safety can be varying through age, gender, income and region of residence of the meals preparers. For

example the cases reported regarding ingestion of raw food, poor hygiene and unsafe practices leading to cross contamination by men are higher than women. Thus, this meta-analysis study also states that the knowledge of food safety practices is able to help a consumer to reduce or prevent cross-contamination in their area (Patil, 2005). The risk of food safety practices often associated with poor hygiene including not washing hands, fresh food product, and raw meat. In addition, the observation study also showed that participants do not wash their hand with soap and water before and during meal preparation (Dharod, 2007). Moreover, consumer often think the most safest food preparation is at home and the common sickness including fever, nausea, diarrhea is not associated with the food prepared at home (Cody, 2003). The unsafe food handling practice at home contributes to foodborne illness and consumer has to spend a lot of money on medical cost (Nesbitt, 2009).

Actor network theory

ANT can be classified into two different categories, human and non-human actor in each network. It can be easily identified in an interaction for example human is representing a living entities and non-human represent technologies, institutions as well as corporations. Actors have the ability to assemble and disassemble therefore they are treated as epistemologically equivalent for the purpose of critical analysis. Evans (1994) state that although it can become an issue for example a person's independence is inhibited by mental sickness or differential power relations including gender or class, the agency of a human actor is largely remain non-controversial. ANT is able to provide empirical and critical conceptual tools necessary to support practical, evidence-based research, ethical and policy issues associated with the commercialization of genetic technologies. The actors in ANT have different degrees of commitment, skill, prejudice, and constraints and often associated with hybrids of the network. At the psychological, economic, social and political levels, they are necessarily heterogeneous which embodying compromises (Latour, 1993). The method of application of ANT falls into three categories and the first category is actor-networks mainly are made up of human and non-human actors that constitute all institutions, groups, and technologies. Second category is translation whereby the interests of actors in networks are aligned through change in order to stabilize or disrupt networks and reduce or increase the complexity. Third category is drift which the transformation of a technology as it is translated into new contexts and used in ways not

previously conceptualized by the actors involved in its initial development. The concept studied by ANT is always change over time across multiple context such as social and political as well as relation with the other network therefore individual actors are defined as ambivalent or ambiguous (Singleton and Michael, 1993). The early study revealed that the characterization of actors such as objects, technologies, organizations is less obvious for some which having at tributes of agency. The other study also found that human behavior is affected through object and non-human entities interaction. For instance, the human impression of a telephone to be just an ordinary and passive technology can be changed when it rings. This happen when human are trying to make decision or draw out a response in relation to the phone calls whether to accept or ignore (Callon and Law, 1995).

Actor-networks

Actor-networks are made up of human and non-human elements which are the shifting systems of alliances to carry out the existence of actors involved. The network is naturally unstable over the time and are maintain through the participation of actors involved which may failed and replaced by different networks. The action of actors and networks between social institutions, individuals and groups will provide a result of interaction. The structure of network can be examined through the root of inspection so that all components can be easily identified, collaborate, co-operate, and compete. Actors and networks that may not be readily apparent will be the challenge for ANT to discover for better understanding of their primary mechanism and components function (Strathern, 1999).

Translation

In every network, there will be a binder or 'glue' to attach and support every actor so that they are capable of resistance and accommodation. This binder is called translation that helps an actor to be independent and able to withstand the diversity in network. In translation, behaviors, motivations, goals and policies can be extracted from the actor which is able to translate and change their interactions with others by themselves (Callon, 1986). The continual translation of every actor for example a person, machine, community, and nation, had influenced the pair of different set of interests in making a stable network. The interaction between the actors especially human and non-human is through a design of scripts which explained the translation to be analogous to negotiation of common interest. Callon (1986)

also introduce four series of translation including problematization, interessement, enrolment, and mobilization which has been added in order to impose and stabilize the identity of other actors. This series assist in stabilizing the network and help to observe how a group of actors can be brought together around a particular goal. Translation is applied to rearrange the relations in actor networks and resistance to change therefore, stability of network is threaten by disagreement or counter-claims that may appear on actors in a network. The actors are considered as “enrolled” when actors and other entities have interest to strengthen or weaken the links between them. The interaction between actors produces networks like building blocks. Latour (1986) state that the control given to the actor is necessarily limited as power is mainly diffused among them meanwhile ongoing translation should be performed at a different levels to identify the organizations, government, institutions, and social order at all time. Nevertheless, it is important to examine the contribution and controlling factors to identify the underlying inequities and power relations towards technology development (Prout, 1996).

Drift

Drift is the situation in which a technology is used differently from the intended. It is fact that technology is changing every day therefore decisions made by various actors and the need to combine into pre-existing social and technological contexts can be a drift (Holmstrom and Stalder, 2001). The actor networks reveal themselves and the norms as well as the value are made apparent when the network failed. Human and non-human actors are extremely important parts of networks as they provide clear insights which enable a critical analysis and valuable critique. In addition, a model of network building produced contains functionalist and determinist analysis which contributes to an understanding of the various interactions between technology, individuals, and organizations (Law, 1999).

Actor network theory application

In 2001, the idea of bringing ANT as tools for analyzing food safety issues has been brought forward by Susanne Freidberg as a methodological approach in the study to examine the food safety and quality in order to restructuring the chain of commodity in fresh food. The ANT has been used to draw a convention theory and as conceptual guidance to identify the production, import and export in commodity chains. Nine years later, a researcher named Diana Stuart has brought this tools back in her study on science,

standard and power which discussing the new food safety framework in California. In the following year, Diana again used ANT in the study of foodborne illness in industrial bagged salad named “Nature is Not Guilty”. In this study, the researcher has point out clearly the used of ANT and the effectiveness towards making critical analysis. The most important information that being point out is foodborne does not caused by nature itself but it has interaction between human and non human. ANT also used by a Belgian researcher named Karijn Bonne in 2007 in the study of the socio-technical construction, quality control, and coordination of the credence quality attribute “halal” throughout the halal meat chain. The study state that, ANT enable the researcher to investigate the procedures of various mechanism interlock to strongly configure the behaviors of the actors involved and allows the researcher to examine the processes of industrial transformation in every stage of food chain. In Malaysia, ANT has been used in the study of halal logistic and the impact of consumer perceptions in the year of 2010. The study focus on analyzing how actors in a network interact with certain product attributes such as the method of production towards the product specification. It is stated that the used of ANT in this study enabling the researcher to be specific by looking into the interaction involved such as quality control, the role of the different stakeholders within the network, and on the specific requirements of customers. Food safety is managed and ensured by both private and public sector efforts domestically and internationally (Caswell and Henson, 1997). In the early 1980s, Bruno Latour and Michel Callon in Paris developed Actor-Network Theory (ANT) with the aim of explaining complex networks in scientific research settings. ANT is known as an approach to the issue between actor, network and technology, and how they connected together in a practice performed (Latour, 1996; Law, 1999). The intellectual tendency born has come to attract wider attention recently within the social sciences and to be seen as important tool for analyzing a network between human and non-human (Nimmo, 2011). A pioneer of ANT suggests that all kinds of extra-social networks between humans and non-humans need to be recognized and made visible (Latour, 1993). In the later year, Michael (2000) state that any kind of networks should not be seen in isolation but always exists. ANT offers a guideline directing attention to the significance of non-humans at the most general level (Latour, 1993; Michael, 2000). Furthermore, the idea of using ANT is for a better critical consideration therefore empirical study should be applied into the practice of science and technology

studies (Hess, 1997). Nowadays, ANT analyses include investigations of science and technology development outside the laboratory including public and private sectors (Law and Callon, 1992; Laet and Mol, 2000) although in the beginning the study only focusing on the laboratory setting (Latour, 1988; Latour and Woolgar, 1979). Law (2004) added that ANT is a useful tool in science and technology for researcher to assist in their understanding towards a complex situation therefore able to critically analyze multiple complications which would remain obscure. Meanwhile in biotechnology sector and disease occurrence, influence of non-humans actor in food systems can be clearly seen through (Goodman 1999; Donaldson *et al.*, 2002; Gouveia and Juska 2002; Juska *et al.*, 2003). Many researchers found that ANT helps in identifying the human and non-human actor in food systems study (Goodman 1999, 2001; Murdoch 2000; Murdoch *et al.*, 2000). In addition, ANT is able to identify the rationality of the networks between humans and non-humans which enrolled and mobilized for specific purpose (Callon 1986; Latour 1987). Beside represents a radical non-humanist analytical stance attempting a more symmetrical approach that considers the role of non-humans in social order, ANT also illustrate relationships and explain how networks are utilize in each situation (Latour 1986, 2005). The goal is to describe the arrangement of network, plan used to sustain order and resistances that appear (Law 1992). Moreover, when non-human actors do not perform as expected or needed, human actors attempt to create networks that they can be very disappointed. Dynamics may shift and relationships may be reconfigured when networks become not stable as controlling all actors in a network remains challenging (Callon 1986). Certain analysis addressed including flexibility and new perspectives are the result produce in most cases of post-ANT work by the scholars including application of the new metaphors to define relationships for example fluid and fire (Mol 2000; Law and Mol 2001; Law 2002; Law and Singleton 2005; Neyland 2006). The radical nature of ANT and early contradictions in the theory have resulted in much debate, however certain aspects has been proven to be clear as ANT revealed the interaction between human and non-human thus leaving the dichotomy of nature and society (Latour 2005). It is a fact that ANT offer insights for exploring the food systems and the growing number of cases where nature and society mixture have emerged (Latour 1993). Study found that adding ANT into the system offers a relational ontology and post-structural insights which are able to create production and consumption, nature and society simultaneously

(Goodman 1999; Murdoch 2000; Gouveia and Juska 2002). Castree (2002) state that combining approach between food safety and ANT together will produce more positive result in understanding a relation between human and non-human actor. This is supported by Kirsch and Mitchell (2004) that combination of approaches helps to explore the main control processes, up to how much degree and how control is opposed. The application of ANT in food safety study must be truly incorporated non-humans and over-looking connections, especially between production and consumption (Lockie and Kitto 2000). ANT represents a significant step towards ridding the sciences of reductionist notions of external nature regardless of its future use and it remains clear as stated by Latour (2005). When ANT expose the relationships in networks, a new associations and new networks are build and in this way, future innovation will be one step ahead (Fenwick 2009; Gad and Jensen 2010). As consumers continuously require sources and trust rather than large-scale industrial producers, an alternative networks demand may continue to expand in response to additional food safety outbreaks (Nygard and Storstad 1998; Murdoch *et al.*, 2000). The next chapter will be the discussion of the application of ANT and its branch.

Conclusion

In this review, study shown that it is useful to have ANT as tools for identify and analyzing the issues in food safety as the ANT offers not only a framework of solution but it also provides a critical review on food safety issues. Many study conducted on food safety issues are only to check the prevalence, but in ANT, this tools revealed the interaction between human and non human subject which can be simplified and turn into an understandable framework. When ANT is used as one of the tools for analysis, it can have a greater problem solving and problem solving as it provide the researcher in transparency in study approach. Earlier, the author has mentioned and discussed about the poor reporting system and insufficient surveillance program worldwide as one of the limitation faced in constructing the data. Therefore, further study should be conducted in order to facilitate the lacking in current reporting system that may lead to poor information on the real burden of food safety. The study on food safety is vital because its strengthen the reporting system and worldwide health organization can able to determine the real burden and estimate the number of affected people so that everyone is aware of the threat in food safety. The threat of foodborne diseases has been shown to

cause morbidity worldwide. Foodborne bacteria are found to be resistant and able to mutate to survive in a dynamic environment therefore, more study should be conducted as is it affecting the human health. Future research should identify the most effective ways to reduce or prevent the contamination from happening such as study on how to prevent contamination from the root of contamination for example at the farm. Foodborne disease gives bad name and impression to the organization and also decreases consumer preference. The study shows that food handlers contribute in increase of rate of foodborne disease as it is difficult for them to maintain the correct practice of handling food. Finally, the author suggests that future researcher should conduct a study with multiple tools to analyze the cases on foodborne disease so that the burden can be controlled. The threat and prevalence of foodborne disease can be controlled by broaden the study area and looking into different perspective of study.

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